M.L. 2017 Minnesota Aquatic Invasive Species Research Center Subproject Abstract
For the Period Ending June 30, 2020

SUBPROJECT TITLE: MAISRC Subproject 20: A Novel Technology for eDNA Collection and Concentration
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FUNDING SOURCE: Environment and Natural Resources Trust Fund (ENRTF)
LEGAL CITATION: M.L. 2017, Chp. 96, Sec. 2, Subd. 06a

SUBPROJECT BUDGET AMOUNT: $190,863
AMOUNT SPENT: $186,527
AMOUNT REMAINING: $4,336

Sound bite of Project Outcomes and Results

The development of a novel filter capable of efficiently extracting Environmental DNA (eDNA) from water, and enabling rapid filtration of large volumes of samples at a reasonable cost, is expected to help convert the eDNA technology from a research curiosity into a routine tool for ecosystem protection and monitoring, and evidence-based management of invasive species.

Overall Subproject Outcome and Results

Background/Context: Environmental DNA (eDNA) is the genetic material (genomic DNA) obtained directly from environmental samples such water. Collection and analysis of eDNA has the potential to provide actionable information on the presence and distribution of aquatic invasive species.

Challenge: The major challenge is that the results obtained from eDNA techniques currently do not always correlate with traditional netting data due to the size and quality of sampling. Unlocking the potential of eDNA requires disruption in sampling methods and tools.

Objectives: This project aimed to develop a novel aquatic eDNA collection and concentration technology for more efficient, reliable and cost-effective screening for not only invasive aquatic organisms and pathogens but also native and endangered species. The technology would significantly enable and empower aquatic ecosystem survey and management programs in Minnesota. Specifically, we aimed to 1) develop an eDNA nanofilter that specifically and rapidly captures nucleic acids (DNA, RNA) from water and enable the processing of large volumes of samples within a short period of time, 2) Verify increased eDNA sampling efficiency of the new nanofilter in field settings (proof-of-concept)

Results and Accomplishments: We have successfully developed a new eDNA filter that captures 50-100% of eDNA within 10 seconds. Commercial kits are incapable of capturing free eDNA. The loading capacity of the new filter is up to 5 mg/g, meaning that 1 g of filter can capture up to 5 mg of DNA. This is a record-breaking capacity that enables the filtration of large volumes of water with one filter, knowing that surface water contains usually 10 ng/L of eDNA.

Following the COVID-19 pandemic, we have adapted the nonfilter to develop an RNA extraction kit for SARS-CoV-2. The new kit was evaluated by the University of Minnesota COVID-19 Diagnostic Laboratory on 80 patient samples, and it showed that our kit has a 100% specificity and 94% sensitivity, which is respectively 12.8% and 5.4% higher than the widely used Qiagen kits

Significance and Impact to Minnesota: Ecosystem conservation managers have been relatively reluctant to use eDNA as a routine tool for ecosystems monitoring. The results obtained here can have a significant impact on the widespread adoption of eDNA technology, which will help the State enhance the accuracy and quality of the data and improve decision making for the management of invasive species. This work has also led to starting a new company, which is expected to accelerate the transfer of the technology to the market, and enhance the industry capacity to respond to the State's need for AIS management.

Subproject Results Use and Dissemination

The results obtained in this project have been presented at three conferences and meetings and will be published through four scientific publications that are currently in process. The work has also been highlighted by the University of Minnesota news service and more media coverage is expected after manuscript publication. The work conducted in this project has also led to the foundation of a new technology company that is expected to take the eDNA filter technology to the market during 2021.

Presentations:

- Zarouri, A., A. Abbas. September 2019. Enhancing fish surveys: A novel technology for environmental DNA capture. MAISRC Research and Management Showcase. Saint Paul, MN.
- Quichen, D., A. Zarouri, A. Abbas. September 2019. A Novel Technology for Environmental DNA Collection and Concentration. American Fisheries Society and The Wildlife Society Conference. Reno, NV.
- Zarouri, A., Q. Dong, A. Abbas. October 2019. A Novel Technology for Environmental DNA Collection and Concentration. 2019 Department of Bioproducts and Biosystems Engineering Research Poster Session. Saint Paul, MN.

Media:

- Detection connections. CFANS News. 9 July 2020. https://cfans.umn.edu/news/abbas-lab-covid-19-update

Attachments:

- Photo of the eDNA nanofilter that was developed as a part of this project.